

1 WHAT IS CLAIMED IS:

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- 3 1. A crude oil desulfurization process comprising the following steps:
- 4 (a) hydrosulfurizing a crude oil feed in a crude desulfurization unit to
- 5 obtain a desulfurized crude oil;
- 6 (b) separating the desulfurized crude oil of step (a) into a light gas oil
- 7 fraction, a vacuum gas oil fraction and a residual fraction;
- 8 (c) hydrocracking the vacuum gas oil fraction of step (b) into at least
- 9 one fuel product having a low sulfur content; and
- 10 (d) hydrotreating the light gas oil fraction of step (b).
- 11
- 12 2. The process according to Claim 1 wherein the step (c) of hydrocracking
- 13 the vacuum gas oil fraction further comprises:
- 14 (a) passing the vacuum gas oil in combination with hydrogen to a first
- 15 hydrocracking reaction zone to create an effluent comprising at
- 16 least one fuel product having a low sulfur content;
- 17 (b) passing at least a portion of the effluent of step (a) to a second
- 18 hydrocracking reaction zone; and
- 19 (c) recycling at least a portion of the second hydrocracking reaction
- 20 zone effluent to the second hydrocracking reaction zone.
- 21
- 22 3. The process according to Claim 2 wherein the second hydrocracking
- 23 reaction zone comprises a multiplicity of layered catalyst beds, including
- 24 at least one hydrotreating catalyst layer which is maintained at reaction
- 25 conditions preselected for high hydrotreating activity.
- 26
- 27 4. The process according to Claim 3 wherein the second hydrocracking
- 28 reaction zone further comprises at least one hydrocracking catalyst layer
- 29 which is maintained at hydrocracking reaction conditions, such that the
- 30 entire effluent from the catalyst layer maintained at hydrocracking
- 31 reaction conditions passes to the catalyst layer maintained at
- 32 hydrotreating reaction conditions.

- 1 5. The process according to Claim 4, which further comprises fractionating
2 at least a portion of the effluent from the second hydrocracking reaction
3 zone and isolating at least one fuel product and a recycle stream which
4 is recycled to the second hydrocracking reaction zone.
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- 6 6. The process according to Claim 3 wherein the step (1) (d) of
7 hydrotreating the light gas oil fraction further comprises passing the light
8 gas oil fraction to the hydrotreating catalyst layer.
9
- 10 7. The process according to Claim 1, wherein step (1) (c) further comprises
11 isolating at least a diesel having a low sulfur content, a kerosene having
12 a low sulfur content, and a naphtha having a low sulfur content.
13
- 14 8. The process according to Claim 2 further comprising:
15 (a) hydrocracking the vacuum gas oil to form a first hydrocracking
16 zone effluent;
17 (b) passing the first hydrocracking zone effluent to a hot hydrogen
18 stripper and isolating a hydrogen-rich gaseous stream and an
19 effluent having a low sulfur content; and
20 (c) passing the hydrogen-rich gaseous stream of step (b) to the crude
21 desulfurization unit for hydrodesulfurizing the crude oil feed.
22
- 23 9. The process according to Claim 3 further comprising:
24 (a) hydrocracking the vacuum gas oil to form a hydrocracking zone
25 effluent;
26 (b) passing the hydrocracking zone effluent of step (a) to a hot
27 hydrogen stripper and isolating a hydrogen-rich gaseous stream
28 and an effluent having a low sulfur content; and
29 (c) passing the hydrogen-rich gaseous stream of step (b) to the crude
30 desulfurization unit for hydrodesulfurizing the crude oil feed.
31
- 32 10. The process according to Claim 9, which further comprises:

- 1 (a) passing the low sulfur effluent of step 9(b) in combination with
- 2 hydrogen to a second hydrocracking zone to produce a
- 3 hydrocracked liquid product; and
- 4 (b) fractionating the hydrocracked liquid product of step (a) to form at
- 5 least one fuel product having a low sulfur content.
- 6
- 7 11. The process according to Claim 10, further comprising passing the low
- 8 sulfur effluent of step 9 (b) to the hydrotreating catalyst layer of Claim 6.
- 9
- 10 12. The process according to Claim 1 wherein step (1) (b) of separating the
- 11 desulfurized crude oil further comprises:
- 12 (a) separating the desulfurized crude oil in an atmospheric distillation
- 13 column and isolating at least a light gas oil and an atmospheric
- 14 residuum therefrom;
- 15 (b) separating the atmospheric residuum of step (a) in a vacuum
- 16 distillation column and isolating at least a vacuum residuum stream
- 17 and a vacuum gas oil stream.
- 18
- 19 13. The process according to Claim 8 wherein the first hydrocracking zone
- 20 effluent of step (8) (a) is passed to a second hydrocracking reaction
- 21 zone without substantially cooling the first hydrocracking zone effluent.
- 22
- 23 14. A crude oil desulfurization process comprising:
- 24 (a) hydrodesulfurizing a crude oil feed in a crude desulfurization unit to
- 25 obtain a desulfurized crude oil;
- 26 (b) separating the desulfurized crude oil of step (a) and isolating a light
- 27 gas oil fraction, a vacuum gas oil fraction and a residual fraction;
- 28 (c) passing the vacuum gas oil fraction of step (b) in combination with
- 29 hydrogen to a first hydrocracking reaction zone, where it is
- 30 hydrocracked to produce a first hydrocracking zone effluent;
- 31 (d) passing at least a portion of the first hydrocracking zone effluent of
- 32 step (c) to a second hydrocracking reaction zone comprising a
- 33 multiplicity of catalyst beds, including at least one hydrotreating

- 1 catalyst layer which contains catalyst preselected for high
- 2 hydrotreating activity;
- 3 (e) passing the light gas oil fraction of step (b) to the hydrotreating
- 4 catalyst layer of step (d) for hydrotreating the light gas oil fraction;
- 5 and
- 6 (f) recycling at least a portion of the combined effluent of steps (d) and
- 7 (e) to the second hydrocracking reaction zone.

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